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ABSTRACT

Continuing education can be looked at as a living system and, as such, assessment is viewed as an integral part of the control function. The use of control functions models of assessment provides a living systems point of view and allows for such new and different questions to be posed as: (1) What are the significant levels of perception and control in our systems? (2) What are the significant controlled quantities? (3) What biases are input functions, directing our attention or enabling us to sense (or ignore) conditions? (4) How do we bias the input functions to detect the controlled quantities more effectively? (5) What are the sources of our reference signals and what effect do they have on our systems? (6) How does continuing education become more responsive to real problems? (7) How are lower levels of control tapped to provide higher levels of control with more direct perceptions of controlled quantities? (8) What is the range of control of our educational interventions? and (9) How much error will our systems tolerate? Such an approach will, hopefully, enable the development of new approaches to studying and applying needs assessment methodology. (CHC)

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ASSESSMENT AND THE CONTROL FUNCTION IN SYSTEMS OF CONTINUING EDUCATION

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ASSESSMENT AND THE CONTROL FUNCTION IN SYSTEMS OF CONTINUING EDUCATION[1]

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Within and beyond the field of educational technology there has been a growing interest in and concern for the identification, analysis and evaluation of "needs" in the systematic process of instructional development. While an increasing number in our field seem to have recognized and become concerned with needs assessment, few, if any, appear interested in establishing needs assessment within a theoretical framework that may give us a better understanding of its nature and function in the systems to which it is applied.

A better understanding is particularly important in continuing education, for it is in this domain that needs assessment most directly interfaces the educational process and the world of expectation, performance and accountability.

Control theory, as it is being developed and applied in the study of living systems, provides a useful theoretical framework for considering, among other things of interest to us, the nature and function of needs assessment in continuing education.

What I am proposing is to present and examine a model of a feedback control system derived from and applied to living systems and to extend its application to continuing education, with a focus on assessment.

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1. A paper presented for the Research and Theory Division, Association for Educational Communications and Technology, Denver, Colorado, April 24, 1980.

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The concept of feedback is familiar to us all. In the simplest modification of the S-R paradigm we find the introduction of the concept of feedback. In learning theory it appears in numerous models, under the guise of Effect, as in the S-O-R-E paradigm (Stimulus-Organism-Response-Effect) or as KOR (Knowledge of Results). In instructional development we find the ubiquitous feedback loop, feeding back information to earlier stages in our ID models and activities.

One of the more interesting and more directly related applications of feedback is found in Miller, Galanter and Pribram's (1960) TOTE unit (See Figure 1), in which the results of an operation phase are fed back as information to a test phase in their model of the structure of behavior. Here we see the first signs of functional assessment (Test) in a behavioral process model.

Missing, however, from the symbolic representation (but not the theory) of the TOTE unit, are two significant components, one of which is of fundamental concern to assessment. Miller, Galanter and Pribram refer to them as Images and Plans. Plans provide the hierarchical control of operations, while Images provide the guidance and direction, the evaluative criteria for the tests.

Since the introduction of the TOTE, Images and Plans in 1960, these constructs have seen a variety of applications, particularly in the fields of neuro-psychology and neurophysiology. Pribram (1971) has since modified the TOTE to incorporate feed-forward, a counterpart to feedback which biases, i.e., predisposes, operations in the TOTE.

William T. Powers (1972) has extended the concept of feedback control and, in so doing, has formulated a powerful and provocative theory of

living systems behavior. The major premise of his theory is that the behavior of living systems functions by means of feedback control organizations to control perceptions. That is to say, what we do is done to control what we perceive. You and I have walked across the room to adjust the picture hanging crooked on the wall. We have behaved to control what we have seen.

A simplified model of a feedback control organization consists of a number of system functions and signals interfacing with some phenomena in the physical world (See Figure 2). Such an organization is part of a hierarchical structure of similar organizations (an idea which I shall shortly attempt to explain). The input function serves to detect the value of some quantity, condition or state of affairs which may be changing as a consequence of an external "disturbance". The input function generates or "computes" a perceptual signal that varies as a function of the detected, controlled quantity. A reference signal, originating elsewhere in the hierarchy of feedback control organizations, represents a goal, value or standard to which the perceptual signal is referenced in the comparator function. An error signal results from the "algebraic summing" of an inverted perceptual signal and the reference signal. So, when the perceptual and reference signals are equal, the error signal is zero. The output function is "driven" by the error signal, operating on the controlled quantity to counter the disturbance and, thereby, changing the perceptual signal. A proper operation will result in bringing the value of the perceptual signal closer to that of the reference signal and, consequently, will reduce the magnitude of the error signal.

As Powers has noted, the reference signal is the most important explanatory feature of the control system unit of behavioral organization. In Miller, Galanter and Pribram's terms, its source is an Image, the reference condition.

A second premise of Power's theory is that there exists in any living system a hierarchy of feedback control organizations such that perceptual signals from lower levels are fed, upward, to higher levels and, conversely, reference signals from higher levels are fed, downward, to lower levels in the hierarchy. That is to say, higher levels of control receive feedback, directly, from lower levels of control as well as providing reference signals to lower levels. Add to this the capability of feeding forward bias signals to input and output functions, predisposing them to detect or operate in certain ways, and you have a complete, if simplified, theoretical model of feedback control in living systems.

Powers has applied the hierarchical principle of perceptual control to human neurological functioning and proposes at least nine levels. Beginning at the lowest level of perceptual control we find perceptions of intensity, sensation, configuration, transition, sequence or event, relationship, program, principles and system concepts. Each in the hierarchy is a function of the integration and differentiation of lower-order perceptions. The lower levels of the hierarchy are well-illustrated by studies in neuro-physiological and behavioral research; the highest levels are least-well investigated or supported, empirically. Although the latter are tentative and speculative, they are logically consistent with the overall theory as well as consistent with current theories of intelligence, information processing and cognitive functioning.

An example from the behavioral laboratory may be in order to illustrate the abstract model.

I am certain you have all seem the video games in department stores or in your homes or the electronic games in shopping center arcades. Imagine a similar arrangement in a laboratory setting: a video screen, a control stick, a moving target and a spot of light to track the target on the screen. Instructions appear on the screen:

> You will accumulate 10 points for every second the spot is within one (spot) diameter of the target. The control stick in front of you will cause the spot to move left, right, up or down. Begin tracking the target.

The target begins to move about on the screen and you manipulate the control stick in an attempt to obtain and maintain the actual, physical relationship between spot and target (i.e., within one spot diameter).

Powers has illustrated the feedback relationships in such a tracking experiment (See Figure 5.1), showing two levels of perceptual control. In a more complex illustration (See Figure 6.1), he analyses a three-level control system in this tracking situation. In a physiological example (See Figure 7.1) he diagrams the tendon reflex loop, showing a first-order control system for the perception of intensity.

The systems in which we work--the educational institutions, industrial and commercial organizations, government agencies and other bureaucracies--are, despite the pejoratives and protestations of some, <u>living systems</u>.

These living systems are purposeful, goal-oriented, adaptive and hierarchically organized and functioning entities ("organisms") to which control system theory can be usefully applied.

In the contexts of continuing education, instructional development and needs assessment, we can apply control system theory in our analyses and our activities to better understand and serve their goals and purposes.

Part of the application is simple, if not obvious. A "need", often defined as the difference between "what is" and "what should be" can be identified as the error signal in the control system model; "what is" and "what should be" can be related, respectively, to the perceptual and reference signals. Assessment, then, resides primarily in the comparator function. But does it? And is that all there is to it? Not quite.

What the theory and model offer is a way of interrelating these components, among others, in a conceptual framework that leads us to consider some of the characteristics of control systems and to ask some questions not asked before. If the theory and model have utility, new insights should develop and new answers should enlighten us and make us more effective in needs assessment.

A number of feedback control prinicples and concepts as they apply to living systems are relevant to needs assessment, especially in the context of continuing education.

First among them is the hierarchial structure of control in a living system.

Control systems, and the assessment functions which are a part of them, are ordered and interrelated in such a way that a control system at one level receives references from higher order systems of control and, in turn, controls perceptions at its own level by adjusting references to lower order systems of control (See Figure 2). Since assessment functions at all levels, measures can be taken which will incorporate input from all levels. For example, in continuing education, there is assessment at the level of the provider, the level of the employer, and the level of the practitioner, to name just a few. Effective assessment in continuing education will tap all significant sources of input for effective control of the quality and impact of continuing education activities and interventions.

A second principle is that each level of control is concerned with a different class of perceptions. What those perceptions are, how they differ, how they are "integrated" and "differentiated" as one proceeds up the hierarchy is relevant to the understanding of the living system. In continuing education, it is important that we understand the differences in levels of perception and are able to integrate and differentiate them at the appropriate levels of control of continuing education.

A third principle, which is a basic premise of this theoretical model of control, is that all control, and therefore all assessment, is dependent on perception. Within this theoretical framework, there is no distinction between "perceived needs" and "actual needs", for every need (i.e., error) is derived from a comparison of a reference condition and a perceived condition. Perceptions are a function of input processes which may be biased by control systems to selectively sense controlled quantities.

A fourth principle concerns the range of control of a system, which is determined by the maximum possible output and the maximum error tolerated by a normally functioning control system. Frequently, continuing education is called upon to provide results which are outside its range of control. Only when the range of control of a system is understood, can assessment be effectively designed and incorporated into the control system of continuing education.

The concept of feed-forward or biasing of functions is particularly significant in living systems control theory. In one sense, reference conditions bias the functioning of lower order systems of control by affecting them in such a way so as to achieve a pre-selected perceptual result. In another sense input and output functions may be biased to detect or operate in a pre-selected fashion. Recognition of the feed-forward or biasing mechanisms, especially as they operate on input functions, is crucial for an understanding and adjustment of assessment function and control.

As I suggested earlier, in continuing education assessment plays a significant role by interfacing the educational process--including instructional development--on the one hand, and expectations, competence, performance and accountability in the system, on the other. This is particularly evident where professional societies, licensing authorities, government agencies, businesses and individuals are looking more and more toward continuing education as the means of developing, maintaining, and assuring professional competency, performance of new and changing services, and increasing quality, efficiency and accountability in the delivery of services.

Let us take, for example, two views of continuing education. In the first

we have provider-centered assessment and control of continuing education (See Figure 3). Here the provider's goals, values and objectives become the references against which sensed conditions are compared. External references, such as enacted legislation, accreditation standards, information on emerging technologies and budgetary factors may contribute to the formulation and prioritization of the internal references. Competence, ideally, is the focal quantity in the real world which continuing education activities and interventions control.

However, the controlled quantities of most direct concern to higher and lower levels in the system (e.g., quality of services or system efficiency) are effected indirectly and are rarely sensed and assessed by the continuing education provider.

In the second view we see learner-centered assessment and control of continuing education (See Figure 4). Here it is the learner's goals, values and objectives which become the reference against which sensed conditions are compared. External references again may contribute to the formulation or prioritization of these internal references. However, at this level of assessment and control, there is a more immediate and direct sensing and control of the focal quantity. At this level, both continuing education interventions (to improve competence) and performance interventions (to affect the controlled quantity) are within the control loop.

Here, at the level of learner-centered control, assessment is an integral part of individual performance, as well as an integral part of the management of performance. I believe it is at this point that continuing education through assessment interfaces with the real world, directly. To have a

conscious awareness at this level of the significant quantities being controlled in performance is to have a valuable source of valid perceptions for and resource in needs assessment for continuing education.

Models representing other views of continuing education might be considered in which the locus of control is found elsewhere in the hierarchical structure of the system. I have selected these two for they represent two common and important loci of assessment and control in continuing medical education, today.

The utility of the theoretical framework offered by this control function model of assessment will come from the questions it raises, the answers it provides, and the improvements it enables. Among the more important and interesting questions may be the following:

1. What are the significant levels of perception and control in our systems?
2. What are the significant controlled quanitities?
3. What biases our input functions, directing our attention or enabling us to sense (or ignore) conditions?
4. How do we bias the input functions to detect the controlled quantities more effectively?
5. What are the sources of our reference signals and what effect do they have on our systems?
6. How does continuing education become more responsive to (sensitive to and effective in dealing with) real problems?
7. How are lower levels of control tapped to provide higher levels of control with more direct perceptions of controlled quantities?

8. What is the range of control of our educational interventions?
9. How much error will our systems tolerate?

The answers will have to await consideration and investigation of these and many other questions generated by this conceptual model.

In summary, assessment is viewed as an integral part of the control function in living systems, among which is continuing education. Needs are a function of the comparison of perceptual and reference signals, being equivalent to the error signal in models of feedback control. The behavior of any living system is considered to be motivated by control functions in order to maintain perceptions of controlled quantities at referenced levels. The hierarchical organization of control functions results in the output of higher levels of control functioning as reference signals for lower levels in the system. Feedback, in the conventional sense, is in the perceptual segment of the closed loop. Feedforward is introduced as the means by which functions are biased or pre-disposed to behave (perceive or operate) in pre-determined ways. Differences in "locus of control" result in different perceptions and foci of control. Continuing education, for example, may involve control at the level of the provider or the level of the learner. At the former level, competence is the focal controlled quantity; at the latter level, performance is. Other levels of control are, of course, likely and manifest. The utility of the control functions model of assessment provides a living systems point of view, allowing us to pose new and different questions and, hopefully, enabling us to develop new approaches to studying and applying needs assessment methodology.

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Powers, W. T. Behavior: The Control of Perception: Chicago: Aldine Publishing, 1972.

Pribram, K. Languages of The Brain. Englewood Cliffs, N.J.: Prentice-Hall, 1971.

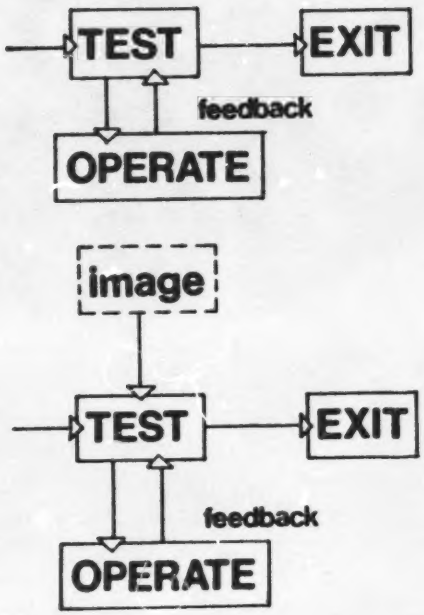

Figure 1. The TOTE Unit (After Miller, Galanter and Pribram, 1960)

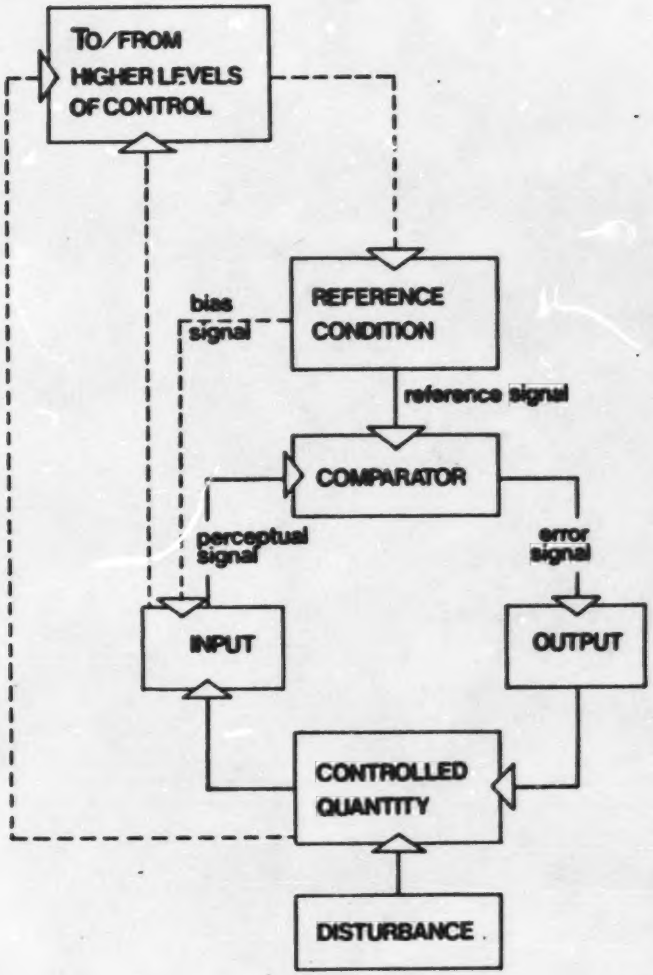

Figure 2. General Model of a Control System and Its Local Environment (After Powers, 1972)

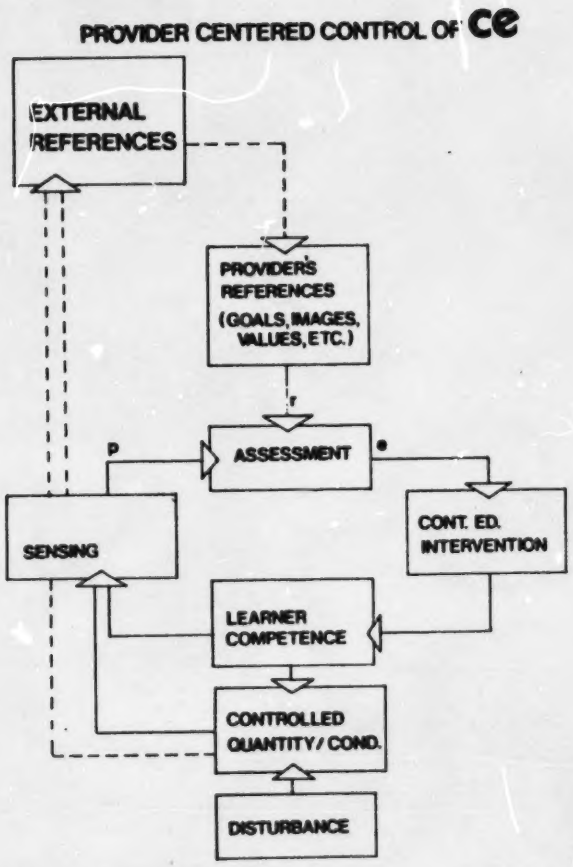

Figure 3. Provider - Centered Control of Continuing Education

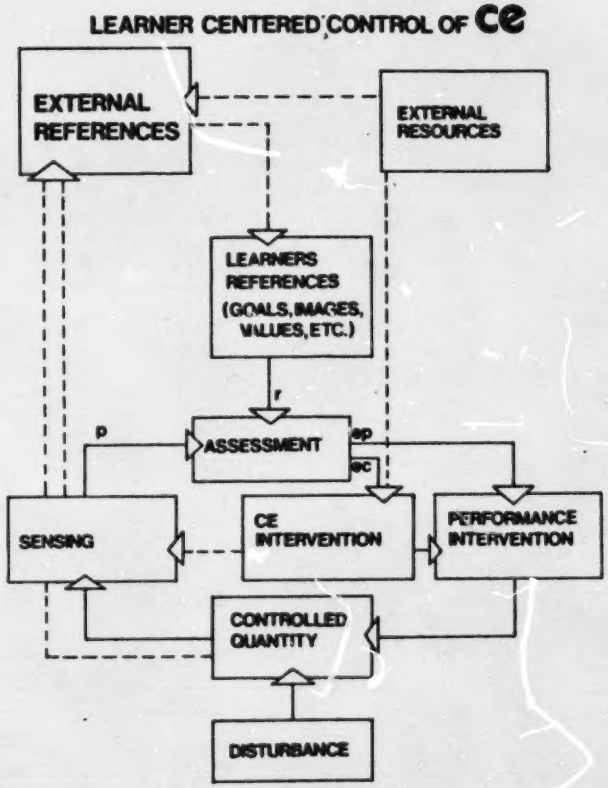

Figure 4. Learner - Centered Control of Continuing Education

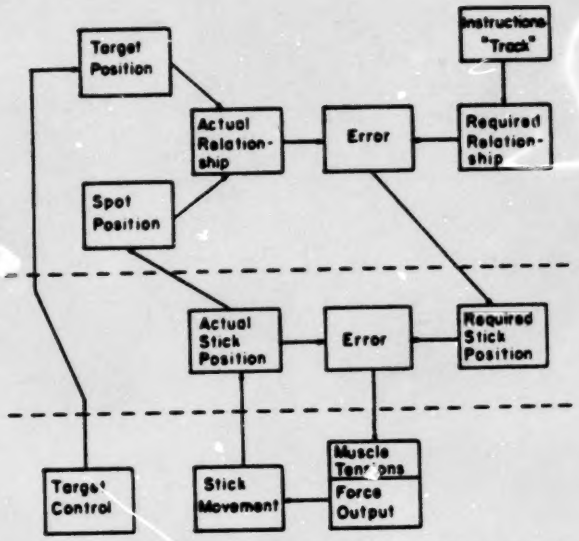

FIGURE 5.1. *A two-level model of feedback relationships in a tracking experiment.*

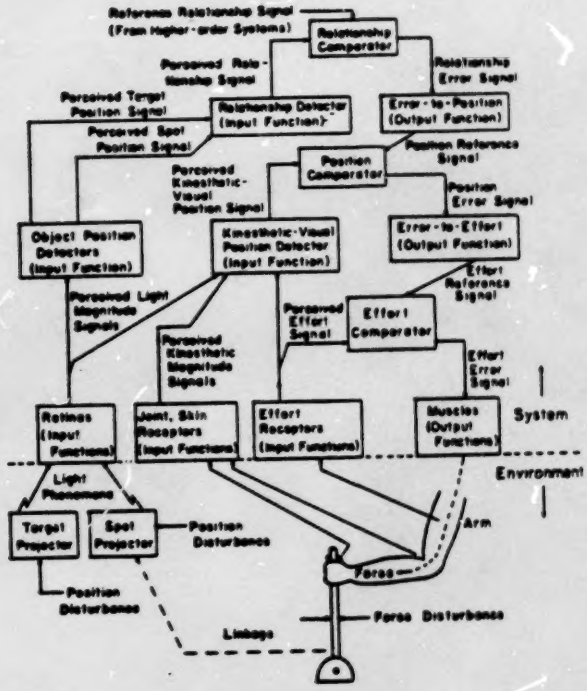

FIGURE 6.1. *A three-level control-system model of a person in the tracking situation.*

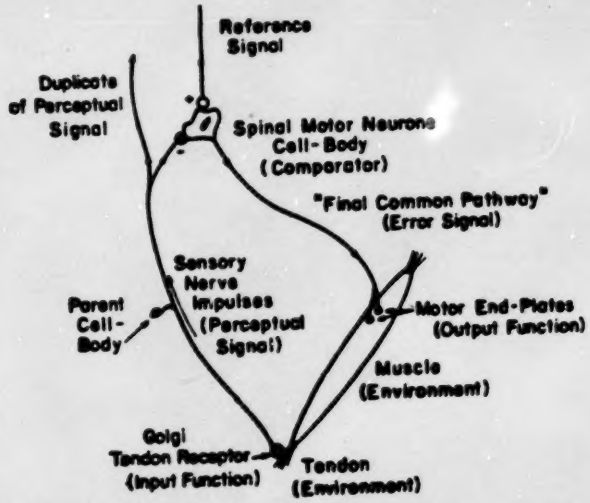

FIGURE 7.1. *The basic first-order control system; the tendon reflex loop.*

Figures 5.1, 6.1, and 7.1 From Powers, W.T. Behavior: The Control of Perception, 1972.